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Implementation of Synthetic Biology for Next-Generation Biofuel Crop Improvement

Abstract.

Meeting the challenge of feeding and fueling an estimated world population of 9 billion by 2050 requires the implementation of new strategies for rapid crop improvement that target not only advanced biofuel traits but also agronomic traits to sustain and increase crop yields in the face of limited water resources and soil fertility and emerging plant pathogens. Conventional plant breeding and biotechnology approaches are making important inroads into meeting these challenges, but these approaches typically target one or only a small number of traits at a single time for crop improvement. In contrast, the emerging discipline of synthetic biology offers tools for making step changes in crop improvement by enabling the precise and optimized integration of many, diverse trait genes into the host crop genome in a single genetic transformation experiment. Research will be pursued using emerging synthetic biology methodologies for rapidly constructing large (>25 kb) gene expression cassettes. Research will focus on proof-of-principle targets that have relevance for biofuel crop improvement. The initial target will be gene combinations that confer improved agronomic properties, such as nitrogen-use efficiency, drought and cold tolerance, with vegetative oil production in the biomass crop sorghum or enhanced biodiesel functionality and novel seed proteins in the oilseed crop camelina. The latter traits will not only increase biofuel functionalities of these crops, but also generate novel co-products for enhanced profitability. Research will focus on sorghum and camelina because these are non-food biofuel crops that UNL researchers are actively studying as components of DOE-funded projects, but the findings of these studies will be generally applicable to improvement of crops, including maize which is central to the US and Nebraska bio-economy. The project will also enable development of expertise to put UNL at the forefront of plant synthetic biology for next-generation crop improvement.